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To Advance the Science of Cold-blooded Vertebrates

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AMIA CALVA GUARDING ITS YOUNG

I HAVE recently become interested in *Amia calva*, the bowfin or mudfish, through a remarkable experience in Lake County, Fla., about the tenth of April. While visiting my friend, Mr. B. M. Kinser, in Eustis, he took me on a trip to the Emeralda Swamp, some 12 or 14 miles distant and covering several thousand acres. There we used a long bamboo pole and noose to catch a number of water snakes—*Natrix sipedon*, *Natrix taxispilotus* and *Natrix cyclopion* to forward to Prof. Blanchard at the University of Michigan, to aid him in his critical examination of this puzzling genus. Having crossed the causeway traversing the swamp, I was standing by a shallow weedy ditch about five feet wide, observing some dark moving objects in the water which proved to be a group of 30 or 40 young of the fish, *Amia calva*, about 3 cm. long, when I was startled by something rushing at me out of the water and up the slightly sloping grassy bank for about eight inches and falling back. At brief intervals it dashed out again several times in an obvious effort to attack and drive me away. A closer examin-

ation revealed a large fish about 14 inches in length close to and guarding the little dark group of fish; between its rushes it lay back among the weeds at the slightly turbid bottom, headed in my direction. When I put the end of my pole in the water, the fish attacked and bit it several times. Mr. Kinser and Mr. E. J. Brown, associated with the Smithsonian Institute, joined me soon after, and the fish again in response to a hostile demonstration on my part made a rush at us and came partly out of the water. To be certain of its identity we then took a wire snare, which we were using in catching snakes, and lifted it out onto the road. The hard exo-skeleton, the long more or less cylindrical body, the mouth, the dorsal bowfin, the rounded tail, and above all the dark spot about 2 cm. in diameter, surrounded by a bright orange-colored border about 3 mm. in width, near the base of the tail, identified it as a male *Amia calva*. The fish was then returned to the water and at a subsequent visit a few days later could not be found.

An appeal to the large experience and cyclopedic knowledge of my friend, E. W. Gudger of the American Museum of Natural History, brought the reply that he himself had no knowledge of any such aggressive terrestrial activities on the part of *Amia*. Of the several references to literature he furnished me, the most illuminating one is that by Prof. Jacob Reighard of the University of Michigan, *The Natural History of Amia calva*, in the Mark Anniversary Volume, 1903. Here in a most exemplary and painstaking study Professor Reighard records a remarkable series of observations, covering the entire life history of the fish so far as it is accessible to investigation, but at no time apparently were any of the fish aggressive in the manner described.

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THE YOSEMITE FAUNA

IT is rather difficult to find comparisons for the recent work on the vertebrate fauna of the Yosemite which Grinnell and Storer have just written.* It most nearly resembles such books as Brewster's *Birds of the Cambridge Region* on the one hand and the accounts or reports of expeditions on the other. For the book is really the report of a careful survey of the Yosemite Valley and corresponds in many ways to the volumes of the North American Fauna. Like them it deals chiefly with birds and mammals, and the generalizations are chiefly concerning life zones, although sets of "associations" are given for each zone.

It will surprise some of those who have believed that sharp change of altitude made the zonal demarcations more clear to learn that the east face of the Sierras is so steep that zonal lines are confused; the western slope, however, being more gentle, the zones are well marked. There is evidently here present an optimum condition for life zones. Most of us who have lived in flatter country (where temperature changes so slowly geographically that scarcely any two forms have the same range and no zonation is observable) have had our eyes turned by others on many occasions towards the hills where, supposedly, we would see zones—but now this clear call is somewhat qualified.

The major part of the book is taken up with discussions of the habitat and habits of the 231 forms of birds and 97 forms of mammals inhabiting the region. Of special interest to readers of *Copeia* are the accounts of the 22 Reptiles and 12 Amphibians found by the field parties.

**Animal Life in the Yosemite.* Joseph Grinnell & Tracy Irwin Storer. xviii-752 pp., pl. 60, fig. 65, 2 maps. U. of Cal. Press, 1924

These latter contained the most interesting finds made: a new race of frog and of fence-lizard (*Rana boylei sierrae*, *Sceloporus taylori*) a new toad (*Bufo canorus*) and a new salamander (*Eurycea platycephalax*), all from the higher altitudes of the Sierras. The last is even more interesting than the authors suggest, for it is not a *Eurycea* at all but closely related to a Sardinian salamander, *Hydromantes genei*. The other member of the genus is *Hydromantes italicus* (*Geotriton fuscus* auct.), more different from *genei* and *platycephalus* than they are from each other. Therefore, instead of being the first west-coast form of an eastern group, the animal is really of a genus new to the western hemisphere and one of the most remarkable zoölogical discoveries of years. The habits of the American form are unknown, as the authors point out, but its European congeners are both viviparous.*

The book is extremely well illustrated, and maps and cross-sections make clear the situation as regards the ranges, associations and zones which are based on them. A better work on the fauna of a limited region can hardly be imagined.

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*Another salamander, *Ensatina croceater*, not taken by the expedition but occurring in the Yosemite Valley (a specimen from Yosemite Valley, Tuolumne Co., Cal., is No. 8167 in the Mus. Comp. Zoöl.), is nearly as interesting geographically. It is almost identical with *Ensatina platensis* from Uraguay and Argentina. The third member of this genus, *Ensatina eschscholtzii* of the Coast Range, is more different from *platensis* and *croceater* than they are from each other.

THE DEVELOPMENTAL HISTORY OF EURYCEA BISLINEATA IN WESTERN MASS.

DURING a period of some eight years many representative collections of the young stages of *Eurycea bislineata* have been made by members of the Department of Zoölogy of Smith College, mainly from a single locality, Bears' Den Brook, on Mt. Toby in Sunderland, Mass. These collections, numbering altogether about 2500 individuals, have furnished material for an extensive study of the normal growth and metamorphosis of the species, the results of which are soon to appear in the *Journal of Experimental Zoölogy*. Incidentally, a fairly complete history of the species from egg-laying to transformation has been formulated and is here given in brief.

Of the mating habits all that can be said is that the fertilization is internal, spermatozoa being received into the spermatheca of the female. Whether or not this is a direct transfer from the male cloaca is not known to us, since we have not as yet succeeded in inducing mating in captivity.

Egg-laying occurs mainly in May, although we have found eggs in early stages of development during the first week in June. Dr. E. R. Dunn has records of eggs from a brook in Northampton in the latter part of April. The eggs are fastened singly by a slender stalk of jelly to the under side of a stone beneath the water. Usually the water appears to be running freely with considerable rapidity under the stone but we have occasionally found batches of eggs on the under side of stones which were wedged down into the mud and gravel near the edge of the stream.

The number of eggs in a batch varies from 12 to 36, the average being about 18, a relatively small number

in comparison with reports from other localities but consistent with the numbers of large ova which we find in the ovaries of gravid females in this region.

Hatching occurs about one month after the eggs are laid and is therefore in progress during June and the early part of July. The newly hatched individuals measure about 14 mm. in length and have still a supply of yolk which furnishes the basis for their growth and development for some two weeks after hatching (*postembryonic* period), during which time the digestive tract completes its differentiation and the mouth opening is formed. This period is a quiescent one, probably spent lying in hollows on the bottom, protected from the currents of water; for, although the newly hatched individuals swim actively against a current, when left undisturbed they quickly settle down to the bottom and remain quiet.

By early August the young larvæ, now thrown on their own resources for obtaining food, begin to distribute themselves in the brook and to appear in representative collections in constantly increasing numbers. By October they form about 72% of a representative collection but by the following spring have fallen to about 40%, indicating a heavy death rate during the winter.

When the larvæ are approximately a year old they have attained an average length of about 33 mm., although they show a large range of variation in size. It is at this time that the majority of them begin to show structural changes looking toward metamorphosis, the most conspicuous one being the formation of the open grooves which will later close to form the nasolacrimal ducts. Unlike most amphibians, however, these metamorphic changes progress slowly and are accompanied by continued growth, and thus cold weather comes on again before transformation has been attained. The majority pass through this second winter in a condition which may be designated *premeta-*

morphic, many indeed not having passed beyond the *incipient phase* of premetamorphosis in which the nasolacrimal grooves are still open. A small proportion have not even reached this incipient phase and thus appear in the collections of the following spring as typical larvæ at a time when the majority of individuals of their own age (two years) are passing through the final metamorphic changes culminating in transformation.

Transformation begins as early as May and reaches its height during July, continuing however during the summer and early fall. The laggard individuals do not achieve transformation during this period and, after passing through a third winter and when nearly three years old, undergo transformation simultaneously with the majority of the next younger set of individuals.

Transforming individuals thus range in age from two to three years, while in length they range from 43 to 76 mm. and in weight from 400 to 1100 mg. There is no apparent correlation between the larger size and the greater age at metamorphosis, since the apparently less successful individuals are the ones in which metamorphosis is longest delayed and, experimentally at least, such individuals do not usually attain the normal average size at transformation.

The largest metamorphic individual of the collections (76 mm.) was a female, and in any collection the few individuals of very large size are more often female than male. There are not enough of these, however, to raise perceptibly the average length of transforming females above that of the males, the average length for each sex being 52.5 mm.

From this account it becomes evident that any representative collection of so-called larvæ comprises individuals of ages ranging from a year or younger to two and three years and in stages of development ranging from the typical larval through the greatly prolonged premetamorphic and metamorphic to trans-

forming individuals. Thus broods of successive years form extensive overlaps and single frequency graphs often show a baffling irregularity of form, the only clew to the solution of which was found in the use of large collections made at frequent intervals and interpreted in the light of actual experimental study of the rate of growth and the conditions which affect metamorphosis.

The developmental history of this species seems to throw some light on the matter of neoteny which for at least one genus of the *Plethodontidae, Typhlomolge,* is an accomplished fact. In *Eurycea bislineata* we see some factor in operation which causes growth to continue for a period of a year or more after the inauguration of the structural changes leading to metamorphosis. Moreover, the gonads show a considerable range of variation in their developmental condition at transformation, although they have thus far always been found to be still immature. It would seem only a step farther in the operation of this delaying factor in metamorphosis to bring about true neoteny.

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